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yet found coal deposits in the permian formation, but the permian is bordered on the whole south side by the genuine coal formation, which covers the latter in almost its entire extent. Coal layers two to eight feet thick come to the surface some miles off from the boundary, and it may with certainty be assumed that stone coal can be reached at a moderate depth near the deposits of iron ore of the permian period. If we cast a glance over the mineral kingdom of northwest Texas, and compare the same with that of England, we discover there the same appearances. In this respect Texas is equally favored, while its coal deposits in the earth, together with those of iron ore, embrace a space double that of England.—*Jacob Boll.*

GEOGRAPHY AND TRAVELS.¹

THE ASCENT OF THE BINUÉ, IN AUGUST, 1879.—Of the few large rivers to be found on the African continent, the Niger and its tributary, the Binué, probably present fewer obstacles to navigation and afford the most uninterrupted means of access to the still unexplored equatorial region. The recent voyage, therefore, of the missionary steamer *Henry Venn*, which succeeded in reaching a point on the latter stream 140 miles further than has ever before been attained by boats is of much importance. We compile the following account of the trip from papers read before the Royal Geographical Society, by Mr. Edward Hutchinson,² and before the Berlin Society, by Herr Ed. Robert Flugel,³ and also from statements furnished by the latter to *Petermann's Mittheilungen*.⁴

Mr. Hutchinson in his preliminary remarks upon the area drained by the rivers Binué and the Shary, discusses the much vexed problem of the identity of the Welle discovered by Schweinfurth, and which he and Keith Johnston believe to flow into the Shary, but which Stanley and Junker consider as belonging to the Congo system.

"The northern and eastern limits of the area drained by these two river systems are now fairly well ascertained. The travels of Petherick, Schweinfurth, Nachtigal, and Dr. Junker, have shown them to be, on the north-east, the ranges which run from the Tibesti mountains, and on the east the ranges which run through Darfur to Mount Baginze and west of the Albert Nyanza, the eastern slopes of which form the gathering grounds of the Bahr el Homr, the Bahr el Gazal, and the White Nile.

"The southern limits of the area we are considering, are as yet unknown. They will probably be found to be ranges of hills of no great elevation, running westwards

¹ Edited by ELLIS H. YARNALL, Philadelphia.

² *Proceedings of the Royal Geographical Society*, May, 1880, p. 289.

³ *Verhandlungen der Gesellschaft für Erdkunde zu Berlin*, Band VII, No. 3, p. 112.

⁴ *Petermann's Mittheilungen*, April, 1880, p. 146 with preface, by Dr. E. Behm, p. 145. See also number for June, 1880, for account of the voyage of the *Henry Venn* from the mouth of the Binué to Djen, also by Herr Flugel.

north of the Congo, and ultimately turning north and joining the range of the Cameroons mountains. These ranges or uplands form the northern and eastern watershed of the Congo, the Ogowé, and the Cross rivers.

"The watershed of the Ogowé has been crossed by the traveler De Brazza, at no great elevation, and Keith Johnston considers that the Ogowé gathers its large volume of waters from numerous tributaries, within a radius of a few hundred miles of the coast.

"The Cross river has been supposed to be a branch of the Niger, but it is more probable that, like the Gaboon river, it will be found to be only a large estuary receiving a number of small tributaries from adjacent uplands.

"It will thus be seen that the north-eastern and eastern limits, and possibly also the south-eastern, are mountain ranges of considerable height, and therefore play an important part as gathering grounds for rainfall, and, though we have no exact data as to rainfall, the mass of water which must fall upon them is enormous.

"The size of the Welle, as indicated by Schweinfurth, in its short course from its chief heads, shows the volume falling upon its highest gathering grounds. The drainage of the western slopes of the ranges, whose eastern sides supply the tributaries of the Bahr el Gazal, must furnish a volume equal to that stream—a volume which would be sufficient to account for the difference between the contents of the Welle, as given by Schweinfurth, and those of the Shary, as given by Major Denham, and to produce that vast body of water which floods the depression called the Bodele, crossed by Nachtigal in 1878, and finds a southern outfall in the direction I shall presently allude to.

"According to the testimony of Major Denham, who made his observations on the 24th of June, 1824, the width of the Shary at its mouth was about a half a mile, while its stream had a velocity of something under three miles an hour. This would indicate a stream three times as strong as that of the Welle, and if the average depth of the waters as they flow into Lake Chad be reckoned at ten feet, it would give a volume of 85,000 cubic feet a second, whereas at the very highest reckoning the volume of the Welle is not above 20,000 cubic feet.

"When Barth crossed the Shary in 1852, a much larger quantity of water was being discharged along its system. He crossed the Logon, a western branch or back-water, and further to the east he crossed the main branch at Mélé. The Logon was a large and powerful river, while the main stream contained more water at Mélé than Denham found at the mouth of the Shary.

"This difference in volume is accounted for by the variation in rainfall, 1851 and 1852 must have been seasons of heavy rainfall, for Barth also found a much greater depth of water in the Binué at Tæpe, than was found by our men last year. It is manifest, however, that the system of the river Shary accounts for the drainage of only a portion of this vast area.

"What outfall is there for the rainfall on the western slopes of the ranges to the north of the Congo and the Ogowé? I think it will be seen that the exploration of the Binué throws some light on this question and tends in the direction of the existence of a lake system somewhat similar to that of the Chad.

"The earliest maps of Africa suggest a large sheet of water in the southern half of the area we are considering. Felipe Pigafetta, on information furnished by Duarte Lopez, places it in two degrees north. It is somewhat remarkable that his is the only antique map of Africa which assigns to the Niger its true outlet, and although he falls into the common error of permitting two or three rivers to flow out of the same lake, yet the general features of his map are so near the truth as to suggest that the Portuguese had a fairly correct knowledge of the interior of Africa, but lacked the scientific methods of stating the information they possessed. Coming to later times, we have Piaggia, who places a great sheet of water in lat. 1° S. long. 24° E. It is true that he himself did not see the lake, but only gives the native report. There appears, however, to be no doubt that upon that meridian Piaggia has penetrated further south than any other European. Schweinfurth, moreover, speaks of him as an acute observer, and though his great lake depends on native report, it must not be forgotten that it was native information furnished to men hundreds of miles from the spot which led to the discovery of Tanganyika and the Victoria Nyanza.

"At the geographical council held by Mr. Stanley, at Kafurro, in Karagwe, there was a prevailing opinion that far to the north-west of the Mfumbiro mountains was a great lake to which no Arabs had ever penetrated. These Mfumbiro mountains are well to the south and on the west of the Albert Nyanza, and the direction thus

indicated points to the quarter in which Piaggia places his great lake. It is not impossible, therefore, that there may be in the southern part of the area we are considering, a system not unlike that of Lake Chad, and that consequently no considerable portion of the drainage from the southern hill ranges finds its way north."

The voyage of the *Henry Venn* was made under the direction of the English Church Missionary Society, their agent, Mr. J. H. Ashcroft, being in command. The vessel was built expressly for the navigation of the Niger. She is 120 feet long, 15 feet beam, 6 feet deep and draws 3 feet 6 inches of water on an even keel, with about 60 tons of cargo aboard. After being occupied for some time on the Lower Niger it was not until the flood season of last year that she undertook the ascent of the Binué, and sailed on that duty from Lukoja at the mouth of the river on July 8, 1879.

As far as Djen the river is well known from the previous expedition of 1854. This point was reached on the 20th of August. The river banks here are about six feet high, the river rather shallow. The people were friendly. A very picturesque range of mountains runs parallel with the river here, about two to three miles distant, inhabited, it is said by Herr Flugel, by cannibals. On the 22d they reached Gamadge, on the left bank, a mile or two below Mount Gabriel, to the west. Mount Gabriel is about five hundred feet high and is covered by very high grass in which the few bushes and trees standing on its sides are nearly hidden. The banks of the Binué are frequently higher than the adjacent country which sinks to the foot of the mountains, and is often swampy and covered by the waters in the time of floods.¹ The men came out in great force here armed with shields and spears, and bows and arrows. They salute here by holding up the right arm and putting the left on the stomach.

On arriving a few hours later at a small place called Iangai, they dispatched messengers to the King of Bassama, and on the 23d the King's son arrived with presents of a cow and a bullock. He seemed "a nice quiet sort of person," but the men who accompanied him were wild and fierce, and during the two days they remained here many threatening demonstrations were made. On the 25th they continued up the stream, passing several small towns. "The people did not seem to like the look of the steamer; it was more than they could understand all at once." "This part of the country is very thickly populated, and it would not take many visits to make very good friends of these people. The current is very rapid just above here; river varied in width; for the distance of 500 yards it narrows to about 250 yards wide, then opens out again to 500 or 600 yards; very few trees about here, only a few monkey-bread trees. Came in view of several new ranges of mountains, at a distance of from eight miles, the nearest,

¹ An interesting note on this characteristic feature of African Geography is given by Herr Flugel. *Petermann's Mittheilungen*, April, 1880, p. 148.

to twenty miles the most distant." On August the 26th, messengers arrived on horse-back from the King of Demsar. [Bassama ?] They were dressed in fine scarlet cloth and brought a tusk of ivory. On the 27th they reached the first village of the Bulas.¹

"I have not seen," Mr. Ashcroft remarks, "any part of Africa so thickly populated as this inhabited by the Bula people. For about twenty-five or thirty miles they are as thick as bees. In fact, since we left Djen, the country is very thickly peopled with fine, strong, warlike, healthy, robust people, that seem to lack nothing but a few more cloths; for they possess cattle, horses, and sheep in abundance, and are everywhere ready to repel invasion, fully armed with spear and shield, or poisoned arrow ready strung, and a quiver full ready for action. They put their hand over their mouths and put it quickly back again, making a shrill noise, 'bla, bla, blu, blu,' in quick succession; some saluted us by holding up the hand, but they never appeared to know what to do, we were so strange to them, coming right into the lion's den; for nothing seeks to pass these hostile Bula villages, nor do I think it possible for any but a good-sized steamer to be able to do this, for thousands of canoes came out during the time we took to pass all these villages. Some villages had 300 or 400 of these canoes, each holding three or four men standing up, with big long paddles, and armed with spears, which they are very expert in throwing, if we may go by what we saw them do when hunting a hippopotamus one day when anchored near while lying off Choma."

"A fine range of mountains on the left bank I called the Buxton mountains, but they are seen to much better advantage near Yola, and are nearer the water. From here they were about nine or ten miles off. Wright range on the right bank, is a splendid range, extending for a long distance, with peaks and terraces from 2000 to 2500 feet, with rugged perpendicular walls of red rock."

On the 28th, another fine range of mountains extending for a long distance along the right bank came in sight.

"Some of the peaks I should think nearly 3000 feet high, the usual height 1500 to 2000; this range extends many miles along, and in some places, near the right bank specially so, just abreast of Yola, with plenty of rock jutting out here and there, of sandstone, much worn. This is Barth's Mount Bagele in all probability." * * "The country which has been, since just above Djen, bare of trees, is now assuming a park-like appearance, with beautiful mountainous scenery on every side, and trees here and there, just like a park at home, and the hills rising from the water side; hitherto there has been more or less plain extending from the river to the foot of the mountains. An artist would have been blessed with the varied play of color, of rocks, trees and bushes, not to mention the rich vegetation, and the deep gullies and weather-worn rocks of many shades of color, some very rugged and bold." * * "Yola stands on rising ground, about three miles from the river, and is a long straggling place, composed of four lots of houses and compounds, *i.e.*, each house surrounded by a piece of cultivated ground, with a fence made of plaited grass, called by the natives, *zenana*."

Leaving the Bula territory they passed into a country inhabited by the Fulahs. This river grew broad and shallow; the banks swampy to the foot of the mountains, lying in broken ranges and reaching on the north side to from 1000 to 2000 feet in height. On September 2d, they passed with some difficulty, through a narrow channel over rapids, passing Tæpe, and arriving at the confluence of the Faro and Binué. The former appeared to be a shallow stream and was said to be full of rocks. The Binué above this point is much narrower, about two hundred yards wide;

¹ Herr Flugel thinks that about 12° 3' E. long. on the northern bank, a large tributary, perhaps the Gongola, has its mouth, but he was not able to examine that portion of the shore.

the banks being overflowed at this period for a long distance inland. The Yarita or Blackstock mountain rises abruptly from the plain near here and appears to have been confounded by Dr. Barth with the Atlantika, which is stated by the natives to be a long distance south. The people on this part of the river were found to be friendly, quiet and industrious, and well clad.

The river has many bends, is very rocky, and frequently the navigation is very difficult and dangerous.

The *Henry Venn* reached her furthest point at Gurua, on September 4th, but the launch went eight or nine miles beyond to Ribago, about a mile from a range of mountains named by the party after Baroness Burdett Coutts. "Magnificent mountains, looking in the distance like a large palace with the center of the building higher than the rest. The finest scenery of the whole river was just about here. I was exceedingly sorry to have to turn back, the country being so beautiful; and the people treating us like old friends, not the least alarmed when we approached with the steamer."

The chief of Gurua told them that canoes could only be used during two or three months in the year. The Kebbi, one of the main branches of the Upper Binué was distant about two and a half days by land, and eight days distant the Binué "comes over mountains" in the Gunderi country. On the next day the river beginning to fill rapidly the *Henry Venn* started on her return down the river and reached Djen in three days, and Lukoja on September 27th.

Mr. Hutchinson in calling attention to the statement that the Binué above the junction with the Mayo Kebbi is a small stream and that therefore the Kebbi is the main branch, expresses the belief that the southern portion of Baghirmi is drained by that stream.

"It seems to rise not far from Tuburi, in a large sheet of water which is separated by a flat level of not more than twenty miles from the large ngáljam¹ of Demmo, which according to Barth, is in direct communication with the western branch of the Shary. Dr. Barth says he was persuaded that in less than fifty years European boats would keep up a regular annual intercourse between the great basin of the Chad and the Atlantic. An almost uninterrupted communication has been opened by nature herself, for, from the mouth of the Kwára² to the confluence of the river Binué with the Mayo Kebbi, there is a natural passage, navigable without further obstruction for boats of about four feet in depth, and the Mayo Kebbi itself, in its present shallow state, seems to be navigable for canoes, or flat-bottomed boats like those of the natives, which I have no doubt may, during the highest state of the inundation, go as far as Dáwa in the Tuburi country, where Dr. Vogel was struck with that large sheet of water, which to him seemed to be an independent central lake, but which is in reality nothing but a widening of the upper part of the Mayo Kebbi. It is very probable that from this place there may be some other shallow water course proceeding to join the large ngáljam of Demmo, so that there would exist a real bifurcation between the basin of the Niger and that of the Chad. But even if this should not be the case, the breadth of the water-parting between these two basins at

¹ Swamp.—Ed.

² The Niger.—Ed.

the utmost cannot exceed twenty miles, consisting of an entirely level flat, and probably of alluvial soil. The level of the Chad and that of the river Binué, near Gewé, where it is joined by the Mayo Kebbi, seems to be almost identical; at least according to all appearance, the Binué at the place mentioned, is not more than 850 or 900 feet above the level of the sea.

"The regular second rise in the Binué which overtook the *Henry Venn* on the 14th of September, would be explained by the draining of the waters through the Mayo Kebbi, caused by the highest rise in the Chad, which occurs in August. This, taken with the vast volume of the water which the rivers pour down, flooding the land for miles, seems to show its connection with a great system.

"Important results to the continent of Africa might follow an effort carefully made to rectify the apparent irregularities of the Shary. If only a portion of the enormous volume of water which is now absorbed and evaporated in the vast expanse of Lake Chad were turned into the Binué, through the Mayo Kebbi, not only would such steamers as the *Henry Venn* have access to that great lake, but they could probably ascend the Shary and Welle almost up to the territories of Munza, King of the Monbuttu."

Meteorological observations were taken on the *Henry Venn* four times during the day. There were no night records. Owing to the steadiness of the atmosphere, the daily variations of the barometer never amounting two-tenths of an inch when the vessel was at anchor, the approximate elevation of the highest point reached may be stated with some approach to accuracy at 624 feet above the level of the Niger at Lukoja.

This makes the average fall of the river to its mouth fifteen inches per mile.

The maximum of the thermometer was 91° , and the minimum 74° . The daily range amounted to only 3° . The average temperature for the whole period of eighty days was 79° . The thermometer did not rise to 80° in fifty-four days, and only reached 75° in nine days while the highest point was only attained once. Rain occurred on twenty-eight days and lightning on twenty-one days.

MICROSCOPY.¹

HOLMAN'S NEW COMPRESSORIUM AND MOIST CHAMBER.²—In working with living animal forms suitable for the elucidation of some of the principal doctrines of life, any contrivance which will render the study easier, and hence more profitable and economical of time, should be hailed with delight by the working microscopist. Such a labor-saving device is represented in the accompanying cut, Fig. 1, of Mr. D. S. Holman's new compressor. This apparatus differs from all other compressors in being so arranged that the mica cover is fixed and immovable, while the lower, thicker plate of glass is moved up and down by means of a screw nut and spiral spring, an arrangement which enables the student to adjust the apparatus so as to apply *with certainty* any degree of pressure upon any soft object without risk of breaking large and expensive cover glasses, crushing the object unex-

¹ This department is edited by Dr. R. H. Ward, Troy, N. Y.

² Advance sheets from Journal Franklin Institute for August, 1880.